

CLAIMS

1. A micromechanical device comprising:
 - a first semiconductor wafer defining a first recessed region formed therein;
 - a semiconductor layer secured to the first wafer opposite the first recessed region, the semiconductor layer including a generally planar horizontal dimension;
 - a cantilever beam formed in the semiconductor layer;
 - wherein the cantilever beam includes a flexure region that is secured to an anchor region of the semiconductor layer;
 - wherein the cantilever beam includes a proof mass region suspended opposite the first recessed region;
 - wherein the flexure region is thin relative to the anchor region of the semiconductor layer.
2. The device of claim 1,
 - wherein the flexure region is thin relative to the proof mass region.
3. The device of claim 1 wherein a vertical dimension of the flexure region is thin relative to a vertical dimension of the anchor region of the semiconductor layer so as to promote rotational movement of the proof mass out of the horizontal plane of the semiconductor layer about an axis through the flexure region in response to an acceleration force applied in a direction generally perpendicular to the horizontal plane of the semiconductor layer.
4. The device of claim 1, wherein the vertical dimension of the anchor region of the semiconductor layer is generally substantially the same as the vertical dimension of the proof mass region.
5. The device of claim 1, further including:
 - at least one piezoresistive sensing element formed in the semiconductor layer adjacent the flexure region.

6. The device of claim 1, wherein the semiconductor layer includes a first sublayer and a second sublayer;
wherein the first sublayer defines the flexure region; and
wherein the first and second sublayers together define the proof mass region.

7. The device of claim 1, wherein the first semiconductor wafer defines a second recessed region formed therein, and the semiconductor layer is secured to the first wafer opposite the second recessed region, further including,
a diaphragm formed in the semiconductor layer opposite the second recessed region.

8. The device of claim 7, wherein a vertical dimension of the diaphragm is thin relative to a vertical dimension of the anchor region of the semiconductor layer.

9. The device of claim 7, wherein a vertical dimension of the diaphragm is thin relative to a vertical dimension of the proof mass region of the semiconductor layer.

10. A micromechanical device comprising:
a first semiconductor wafer having a generally planar horizontal dimension and defining a first recessed region including first and third opposed sides and second and fourth opposed sides;
a semiconductor layer that has a generally planar horizontal dimension and that is secured to the first wafer;
wherein the semiconductor layer defines an anchor region adjacent the first side of the first recessed region and defines a suspended structure including a proximal end secured to the anchor region and a distal portion suspended opposite the first recessed region;

wherein the distal portion of the suspended structure includes a seismic mass; and

wherein a vertical dimension of the proximal end of the suspended structure is thin relative to a vertical dimension of the seismic mass so as to promote generally rotational movement of the suspended structure about a generally horizontal axis through the proximal end of the suspended structure and in a direction generally perpendicular to horizontal dimensions of the semiconductor wafer and the semiconductor layer in response to an acceleration force applied in a direction generally perpendicular to those horizontal dimensions.

11. The device of claim 10, wherein a vertical dimension of the proximal end of the suspended structure is thin relative to a vertical dimension of the anchor region.

12. The device of claim 10, wherein the proximal end of the suspended structure is secured to the anchor region opposite substantially an entire length of the first side of the first recessed region.

13. The device of claim 10,
wherein the semiconductor layer includes a first sublayer and a second sublayer;

wherein the first sublayer defines the proximal end of the suspended structure; and

wherein the first and second sublayers together define the seismic mass.

14. The device of claim 10,
wherein the semiconductor layer includes a first sublayer and a second sublayer;

wherein the first sublayer defines the proximal end of the suspended structure;

wherein the first and second sublayers together define the seismic mass;
and
wherein the first and second sublayers together define the anchor region.

15. A method of using a beam formed in a generally planar semiconductor layer and suspended over a recessed region of a generally planar semiconductor wafer to sense acceleration comprising:

applying an acceleration force in a direction generally perpendicular to the planes of the semiconductor wafer and of the semiconductor layer; and

sensing flexure of the beam in a direction generally parallel to the direction of the acceleration force.

16. A process of fabricating a micromechanical device comprising:
providing a first semiconductor wafer having generally planar horizontal dimensions;

forming a recess region in the semiconductor wafer;

securing a semiconductor layer to a surface of the wafer opposite the recess region,

wherein the semiconductor layer includes a vertical dimension generally perpendicular to the generally planar horizontal dimensions of the first semiconductor wafer and includes a horizontal dimension generally parallel to the generally planar horizontal dimension of the first semiconductor wafer;

forming a suspended structure in the semiconductor layer disposed opposite the recess region,

wherein the suspended structure includes a vertical dimension generally parallel to a vertical dimension of the semiconductor layer and includes a horizontal dimension generally parallel to a horizontal dimension of the semiconductor layer;

wherein the suspended structure includes a boundary region that is released from other portions of the semiconductor layer except in a flexure region of the boundary region;

wherein the suspended structure includes a seismic mass region within the boundary region;

wherein the flexure region of the boundary region and released portion of the boundary region are disposed to permit generally rotational movement of the seismic mass about an axis through the flexure region and in a direction generally parallel to the vertical dimension of the semiconductor layer; and

wherein a vertical dimension of the flexure region is thin relative to a vertical dimension of the seismic mass region so as to promote such rotational movement in response to an acceleration force applied in a direction generally perpendicular to the horizontal dimension of the semiconductor layer.

17. The process according to claim 16, wherein the act of securing includes silicon fusion bonding.

18. The process according to claim 16, wherein the act of forming the suspending structure includes etching substantially vertically through the semiconductor layer with a deep reactive ion etch.

19. The process according to claim 16, further comprising implanting at least one piezoresistive sensor element to sense flexure in the flexure region.

20. The process according to claim 16, wherein the act of securing a semiconductor layer includes securing a first sublayer and securing a second sublayer;

wherein the first sublayer defines the flexure region of the suspended structure; and

wherein the first sublayer and the second sublayer together define the seismic mass region of the suspended structure.

21. The process according to claim 16, wherein the act of securing includes:

providing a second wafer with the semiconductor layer formed thereon;

forming a recess in the semiconductor layer;

securing the semiconductor layer to the first surface of the wafer;

and

removing the second wafer.

22. The process according to claim 21, wherein removing the second wafer includes etching the second wafer.

23. The process according to claim 16, wherein removing the second wafer includes an electrochemical KOH etch.

24. The process according to claim 16, further including forming the suspended structure in the semiconductor layer with a KOH etch.

25. The process according to claim 16, further including forming the suspended structure in the semiconductor layer with a deep reactive ion etch.

26. The process according to claim 16, further including:

forming a second recess region in the wafer;

forming a thinned region in the semiconductor layer, and

disposing the thinned region opposite the second recess region to allow flexure in a direction generally parallel to the vertical dimension of the semiconductor layer.

27. The process according to claim 26,
wherein the semiconductor layer includes a first sublayer and a second sublayer;
wherein the first sublayer defines the flexure region of the suspended structure.

28. A micromechanical device formed on a semiconductor wafer in accordance with claim 16.

29. A micromechanical accelerometer sensor formed on a semiconductor wafer in accordance with claim 16.

30. A micromechanical accelerometer sensor and pressure sensor formed on a single semiconductor wafer in accordance with claim 26.